Jet Propulsion Laboratory
California Institute of Technology

4800 Oak Grove Drive
Pasadena, California 91109

(818) 354-4321

JPL

October 12, 1987

TO: Distribution

SUBJECT: Preliminary User Operations Interface Plan

The enclosed document, **Preliminary Space Station User Operations Interface Plan**, was prepared by Randy Cassingham and others as a tool to be used by Space Station Program and user management to estimate and understand the levels of support required to prepare for early Station payloads.

Based primarily on results of the Operations Task Force, this document presents an ordered listing of documents, information, and hardware which must pass across the interfaces between Station users, their sponsors, and the Space Station Program. Readers will see that a great deal of work is ahead to create an effective and mutually understood working relationship among these three parties for any given payload. It is hoped that many of the pitfalls encountered in this area by Shuttle payloads can be avoided with the Station.

As this deliverable is for a discontinued Level B task, no formal follow-up is intended except for a final edit and assignment of a document number. The preliminary plan will be used at JPL until better information is available for estimating the level of support required to develop payloads for the Station.

Comments are welcome, and may be directed to either Randy Cassingham (NASAMAIL: RCASSINGHAM, FTS 792-1273) or to me (RSTAEHLE, FTS 792-1176, 1100).

Sincerely,

Robert L. Staehle
Systems Analysis Section

RLS:

enclosure

JPL D-4887

Preliminary Space Station User Operations Interface Plan

Randy Cassingham
Systems Analysis

1 October 1987

National Aeronautics and
Space Administration

JPL

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Preliminary Space Station User Operations Interface Plan

Introduction

This document is intended to be used by prospective payload developers and Space Station Program personnel to aid them in preparing schedules, estimating cost and personnel resources, and planning user flow through the Space Station system. The backbone of this document is a preliminary time-ordered listing of the deliverables and general technical content of information and equipment which needs to pass among Space Station users, user sponsors, and the Space Station Program throughout the lifecycle of a user's activity with the Program.

The plan in this document is centered on a "generic" payload installed on the manned base. Using this plan, later efforts may define interface plans for other user classes such as an equivalent to Shuttle "Getaway Specials", quick-integration (or "Quick is Beautiful") users, and others (Ref. 1). Very complex payload interfaces, such as those for multiple-launch assembly and staging missions, will presumably have to be planned on a case-by-case basis.

Information in this document is derived from work performed at JPL on User Operations Support definition, User Operations Policy, User Documentation Development, investigator experience with Shuttle payloads, and preliminary results from Space Station Utilization Case Studies (Refs. 2, 3, 4, 5). Information about Space Station Program plans is derived from a number of sources, including the Space Station Operations Task Force (OTF). The integration plan is based on the OTF's User Integration Scenario (Ref. 6).

This document comprises the final deliverable for JPL's Customer Operations Planning task, originally sponsored by the Level B Customer Integration Office. The work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Recommendations

1. The Program must create and establish the products (documentation, testbeds, forms, etc.), groups, offices and positions listed in the plan outlined in this report in time to be used by the developers of the first payloads to be launched to the Space Station.

2. Because of the extreme complexity of the Space Station Program, the Program offices must exercise utmost care to ensure that the interface between the Program and the user is clear, concise, and free of unnecessary burden on the user or the Program.

3. The Program must be sure to have a *single* point of contact through which the user can secure all needed documents, consultations, negotiations, resources, etc.

4. The Program must ensure that the information flow to the user is complete, timely, and — especially — that it is easily accessible to the user. Users must take care to have the latest information regarding policies, resources, capabilities, procedures, performance, reimbursement and other useful information to ensure that all necessary information is on hand when it is needed. This will also help to ensure that there are no last-minute surprises for users that will adversely impact their investigations (as with time delays or increased cost).

5. Updated information needed by the users should be regularly posted on TMIS so that users may ascertain whether the information they possess is the most up-to-date possible. Users and their sponsors should have access to TMIS as their principal medium of electronic communication with the Program.

Background

The Space Station Program will be very complex — and a large number of investigators will use the Space Station — so a well-defined and useful interface between the Program and the users must be developed to ensure efficient utilization. The most complete description of a user interface to date was set forth by the Space Station Operations Task Force (OTF). As a part of the OTF's final report, a "User Integration Scenario" was outlined. To help clarify the OTF's inter-

face and to point out where further definition is needed, the plan in this paper was mainly adapted from the text of the OTF's scenario, and then augmented with input from other sources.

The plan is presented in three columns. The first column shows actions that must be taken by any of the NASA offices of the Space Station Program. The second column lists actions taken by the user. The third column shows participation by user sponsors, such as the Office of Space Science and Applications, the Office of Commercial Programs, and the Office of Aeronautics and Space Technology. Originally, a fourth column was planned to show the actions' time relative to launch. Unfortunately, a clear estimation of *when* a particular action should take place could not be extrapolated from the OTF's scenario. **Setting times to the actions in the scenario should be a top priority** — this would show the Program very clearly that there is a limited amount of time left to complete the documents and form the groups and necessary offices to establish the user interface.

The plan in this paper has been set out as much as possible in order of occurrence from top to bottom and from left to right. Since not all payloads are alike, however, it must be realized that deviations in order and timing may occur. It is thought, however, that the sequence of events as outlined in this paper will be helpful to the Program and users in their understanding of the requirements for the user interface.

Whenever additional steps beyond those noted in the OTF scenario could be identified or suggested, they were added (and are enclosed in [square brackets] for clarity). Because the OTF scenario outlines a **proposed** approach to the user interface, refinements will likely be introduced as the Program matures. We suggest that, as the Program interface definition evolves, the steps in the plan must be made more precise and relative timing should be determined to assist the Program in defining the most effective user interface possible.

Ramifications of the Plan

— to the Program

Many of the documents, offices and other items noted in the plan do not exist at this time. In order for the Space Station Program to be ready for the first user, these products need to be fully specified and created in time to be utilized by the first user. Assuming that the first payload will be launched in 1994, the Space Station Multilateral Control Board must allocate the Station's resources among the Partners, the U.S. Space Station User's Board must allocate U.S. resources among the

sponsoring NASA offices, and the sponsoring NASA offices must allocate their resources among disciplines and have issued Announcements of Opportunity no later than 1989. Level 1 documentation (Ref. 5) should be in the first user's hands *now*, and levels 2 and 3 should be ready by 1988.

These dates are based on a reasonable estimation of the period required for an effective payload to be developed, flight qualified, and delivered. The 1989 date leaves less than a two year lead time for the creation and emplacement of the necessary administrative organizations and appropriate documentation. The creation of many of these actions, documents and offices haven't yet been initiated, showing the need for

Acronyms and Abbreviations Used

AO	Announcement of Opportunity
CUP	Consolidated Utilization Plan
DOC	Discipline Operations (control) Center
FIP	Flight Increment Plan
IWG	Investigator Working Group
MCB	Multilateral Control Board
MRDB	Mission Requirements Data Base
OCP	Office of Commercial Programs
ops	Operations
OSF	Office of Space Flight
OSSO	Office of Space Station Operations
OTF	Operations Task Force
PAM	Payload Accommodation Manager
PIP	Payload Integration Plan
POCB	Payload Operations Control Board
POIC	Payload Operations Integration Center
RFF	Request for Flight (form)
S&T	Science and Technology (Center)
SE&IO	System Engineering and Integration Office
SSSC	Space Station Support Center
SSUB	Space Station Users Board
SSUWG	Space Station Users Working Group
TDRSS	Tracking and Data Relay Satellite System
TOP	Tactical Operations Plan
UODD	Utilization and Operations Development Division (of OSSO)
UOF	User Operations (control) Facility
UOIO	Utilization and Operations Integration Office (division of OSSO)

immediate action.

Steps must be taken to streamline the user interface as much as possible for the users to get the most from the Program (Ref. 7). Printed documentation, which will be the first contact with the Program for most users, needs to be well defined, concise, consistent, and useful (Ref. 5). In order to pave the way for the investigators who will utilize the Space Station, the Program must act immediately to lay out a useful Program-to-user interface.

— to Users and their Sponsors

By reading the plan, users will get a general idea as to what will be required of them as they proceed through the Program. The Space Station is a complex system, and users must acknowledge that a certain period of time will elapse between the conception of an experiment and flight. Thousands of pages of documentation will pass between each user and the Program. Reviews will take place not only to ensure the safety of the user's payload, but also to verify the compatibility of the payload with the goals of the sponsor and the capabilities of the Station. By having a realistic view of what is required before committing to the Program, users will be less likely caught off guard as Program requirements unfold before them.

The sponsors will see not only what actions are required of them, but also will understand the complex process their users will be going through. The sponsors will be able to support their users better as they progress through the Program if they know in advance where problem areas lie.

Unresolved Issues

Three of the most apparent unresolved issues are listed below. Many more will likely be uncovered as different offices begin detailed planning of the elements described in this plan.

1. What is a "complete" range of Station resources (this plan, page 4, bottom of second column (original source: Ref 6, page III.D-8)) that would require a user to participate in the planning process? What does a user give up by entering the planning process later than this point? What provisions are made for "Quick is Beautiful" payloads, which almost by definition will enter the planning process late?

2. What is the definition of the "particularly complex payload execution requirements" payloads that will require "two high-fidelity copies" (this plan, page 7,

near bottom of second column (original source: Ref. 6, page III.D-11)) to be presented to the Program for training purposes? Is this requirement necessary?

3. If the "POIC coordinates user commands and consolidates them for transmission via the SSSC, and also monitors all user ops to ensure conformance to execute ops plan and to detect any hazardous changes or trends" (this plan, page 9, near center of first column (original source: Ref. 6, page III.D-12)), how does the concept of Telescience (or "teleoperations") fit in? It seems that real-time operations are incompatible with this concept.
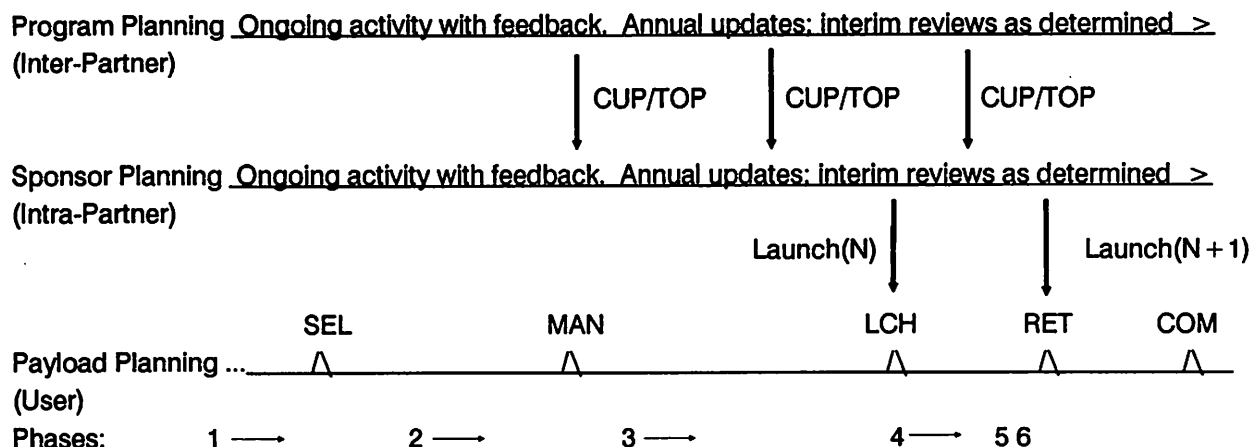
References

1. Jackie A. Giuliano, *Utilizing the Space Station Volume I — Policy Guide*, JPL Document D-(tbd), draft of 30 September 1987.

2. Paul K. Henry and Jeff S. Keys, *A Space Station Science Operations Scenario*, JPL discussion paper, 6 March 1987.

3. Jackie A. Giuliano, *Proposed User Operations Support Concept for Space Station*, JPL discussion paper, 14 January 1987.

4. Robert W. Easter and Robert L. Staehle (editors), *Science Operations in the Space Station Era*, JPL document D-2403, 21 June 1985.

5. Randy Cassingham, *Space Station User Documentation: Lessons from the Space Shuttle*, JPL document D-4487, 30 June 1987.

6. Peter Lyman and Carl Shelly, *Summary Report of the Operations Task Force*, 20 July 1987.

7. M. Laura Crary, *Lessons for the Space Station: JPL's Perspective on the Shuttle Payload Process*, JPL document D-3891, 1 March 1987.

8. Robert L. Staehle and Randy Cassingham, *Resource Categories for Space Station Activities Planning*, JPL discussion paper, 31 July 1987.

Acknowledgements

Overview of Planning Sequences

Program Planning <u>Ongoing activity with feedback. Annual updates; interim reviews as determined ></u>
(Inter-Partner)

| CUP/TOP | CUP/TOP | CUP/TOP

Sponsor Planning <u>Ongoing activity with feedback. Annual updates; interim reviews as determined ></u>
(Intra-Partner)

Launch(N) | Launch(N + 1)

	SEL	MAN	LCH	RET	COM

Payload Planning ...___Λ_____Λ_____Λ____Λ____Λ____
(User)

Phases: 1 —→   2 —→   3 —→   4 —→ 5 6

<u>Phase</u> <u>Activity</u>

Phase	Activity
1	Initiation and proof of concept
2	Concept development; feasibility analysis; prelim design
3	Payload development; test & delivery; logistics planning
4	Payload launch; installation; operation
5	Results analysis; lessons learned; phase out
6	Payload optionally stays for additional increments

Key

SEL = Select payload for flight
MAN = Manifest on Increment(N)
LCH = Launch for Increment(N)
RET = Return from orbit
COM = Completed mission

Comments:

1. The coordination of the CUPs and TOPs by the Partners is an ongoing process.

2. The period between payload selection (SEL) and launch (LCH) may be as much as five years. This time should be "compressible" to less than one year for some simple and "Quick Response" payloads. Manifesting may occur at any time after selection. The period of time between launch and return will be a minimum of approximately 45 days.

3. It is useful to differentiate those planning activities that are ongoing (general operations planning) from the one-time events incurred by an individual payload. Therefore, top-level Program management activities are displayed on separate timelines that indicate how these activities drive the specific payload planning events. This could be broken out in more detail for various lower layers of organization as well.

4. Payload planning for a given Flight Increment will depend the Station's configuration during that Increment, and on the Station's capability to provide various resources to payloads (Ref. 8). Planning will also depend on any specific discipline emphasis or utilization theme selected for the Increment. Therefore, until the configuration and any mission theme is known, there are progressive uncertainties in the earlier (pre-launch) phases that require wide tolerance limits in discussing generic payload timelines related solely to launch date. However, the various activities that occur within each of the designated phases (or some such partitioning) can be discussed more reliably — then, each task can be related to the next upstream milestone (i.e., one month before manifesting, or launch minus 10 days). Also, payload developers must anticipate constraints and holding times imposed by payloads with which they are to be integrated. These estimated uncertainties also are perhaps less unwieldy if related to a sub-partitioning of pre-launch timelines, since presumably each payload comprising the Increment's "cargo" will be subject to the same interim deadlines.

Actions by the Space Station Program	Actions by the User	Actions by the NASA Sponsor
[Program Office distributes list of all Program documentation, and distributes Level 1 (intro & general info) and Level 2 (general solicitation of user interest) documentation]*		
Multilateral Control Board's (MCB) Systems Ops Panel provides the MCB a projection of available user resources over the coming 5 years and recommends allocation to the Partners.		
MCB notifies Partners of available user resources.		
U.S. Space Station Users Board (SSUB) divides U.S. allocation among the user disciplines [i.e., sponsor offices].		
The Office of Space Station Ops' (OSSO) Utilization and Operations Development Division (UODD) alerts the potential user community via articles, brochures, etc., but, the sponsor Program Offices bear primary responsibility for marketing.		The sponsor Program Offices (User Codes) may subdivide their resource allocations into sub-blocks alloted to their component disciplines (microgravity, Automation & Robotics, astrophysics, etc.)

* Items enclosed in [square brackets] are steps and comments added by the author to what was included in the OTF scenario.

Program Actions	User Actions	NASA Sponsor Actions
UODD provides sponsors specific cost and technical info and develops standard forms for user/Station agreements.		NASA sponsors issue AOs and perform main marketing tasks.
UODD or Office of Commercial Programs (OCP) perform outreach activities to attract commercial users.	[User contacts OSSO or sponsor for info to conduct Station utility assessment.]	[Sponsor distributes Level 3 documentation (describes utility and competitiveness of the Station for a particular application).]
	[User performs assessment of the Station's utility to accommodate his particular need.]	
	User submits a formal proposal with UODD's [or sponsor's] assistance.	
Proposal undergoes reviews to determine its compatibility with the goals, capabilities and constraints of the Program and the resource allocations.		Sponsor reviews proposal to determine compatibility with Sponsor's goals and selects from approved payloads for [payload] definition.
[Program provides sponsor offices with realistic cost estimates for Station use.]	User provides information for the Mission Requirements Data Base (MRDB).	
Utilization and Ops Integration Office (UOIO) uses MRDB to perform payload feasibility assessment against Station systems and ops.	User develops a Request For Flight (RFF) form (similar to STS-100).	Sponsor provides user with "best effort" commitment to costs for access to Station.
[Program issues Level 4 documentation (Technical Utilization/Payload Development info) to user.]	User reviews [specific] restrictions and requirements the Program will impose on payload and activities [and makes required design updates].	

UOIO submits the RFF and formal proposal to SSUB for review.

Payload (proposal) is evaluated by the Program for acceptance pending final approval by the MCB.

Payloads (proposals) are forwarded to the User Ops Panel (UOP) for consolidation with payloads approved by other Partners.

[User, with help of Level 3 documentation and sponsor input, determines best transportation method and requests type of launch vehicle.]

UOP combines all selected payloads into a Consolidated Utilization Plan (CUP) and forwards it to MCB for final approval. The CUP lists all major utilization and ops activities planned for the next 5 years, and assigns payloads to a particular year and quarter and to a particular transportation system.

Space Station Associate Administrator signs off on the CUP and RFFs -- users have a commitment to fly.

Sponsors initiate payload development.

User Accommodations Integration Office assigns user a Payload Accommodation Manager (PAM). All requests from the Program to the user will be routed through the PAM.

User may utilize the PAM for contact with all offices in the Program or, if he chooses, he may deal with these offices directly.

Program Actions	User Actions	NASA Sponsor Actions
[Program provides design tools, interface templates, simulation and testbed facilities to aid user in payload development.]		
[Program office issues Level 5 documentation (mission-specific).]	User becomes a member of the Space Station User's Working Group (SSUWG).	
	User develops Payload Integration Plan (PIP) and its annexes with assistance from his PAM.	
PAM arranges for initial (Phase-Zero) safety review.	User assembles a development plan for payload and ground ops.	Sponsor and PAM assist user create development and ground ops plans.
	User defines his requirements for [sharing and] coordination with other users.	
PAM arranges for reviews (including Phase-one safety review) and briefings with all institutional ops offices involved with supporting the payload.	User provides PAM with updated payload information (reflecting any changes made as a result of reviews) to support updates to MRDB, PIP, and PIP annexes.	
UOIO combines requirements from all users (incl. Partner-nominated) to assign payloads to a new flight increment. The new increment is added to the Tactical Ops Plan (TOP).		
TOP is approved by all partners via the Program Ops Control Board (POCB). A crew is assigned.	User enters the Program planning process if he requires a "complete" range of Station resources. Users entering the increment after this time will be restricted with regard to the range of payloads they can implement.	

User Integration Plan

An Increment Change
Manager is assigned to
oversee all planning,
ops, and integration.
The TOP assigns primary
Station ops, maintenance
and servicing activity
time intervals (but not
detailed timelines or
directions).

The Systems Engineering
and Integration Office
(SE&IO) arranges for
transportation and its
manifests, and transpor-
tation and data system
manifest documentation,
[for logistics and
payloads].

TOP and manifests are
forwarded to the Manned
Base User Ops Office, the
Manned Base Systems Ops
Office, the Logistics Ops
Office, and the Pre- and
Post-Flight Ops office
and developed into pre-
and post-flight ops plans
and Flight Increment
Plans (including crew
training and simulation
plans, and logistics
plans).

Crew user training
begins. If a [user's]
payload scientist will
operate the payload, he
will be trained in
Station ops.

The TOP is sent to the
Office of Space Tracking
and Data Systems for
development of TDRSS/
network ops plans.

Program Actions	User Actions	NASA Sponsor Actions
Office of Space Flight performs supportability assessment based on OSSO manifests.		
The Manned Base System Ops Office develops an Increment Hazard Control Plan, which is reviewed by the Ops Safety Office.	All users in the increment join the Investigator Working Group (IWG) to participate in execution-level planning.	Sponsor and PAM supports user through Preliminary Design Review.
Phase-Two safety review.		
		Sponsor assigns most of its users to a Discipline Ops Center (DOC) which will coordinate ops during flight preparation and execution (known as "discipline users"). Other users (esp. commercial) may choose to build their own User Ops Facility (UOF) which will link with the Station and other users via the DOC or the POIC (known as "direct users").
	User trains ground ops facilities staff as necessary. Ground facilities will be required to provide all capabilities necessary to allow the user to perform any required teleoperations.	S&T Centers, Sponsors, POIC and PAM all support the user in developing payload, ops plans and ground facilities.
	User updates and refines payload requirements.	
Increment change manager coordinates assessments by the Space Station Support Center (SSSC), POIC and other offices.	User undergoes final ops assessments.	PAM and Sponsor support assessments.
Based on assessments, an increment crew assigned.		

User Integration Plan

Program Actions	User Actions	NASA Sponsor Actions
The user ops execution plan is consolidated by the SSSC with Station systems requirements into a preliminary Flight Increment Plan (FIP).	User participates in the development of the FIP, which is refined continuously until it is finalized.	
SSSC updates resource envelope available to users; POIC adjusts resource assignments to the DOCs and other (direct) users.	Users develop refined and updated ops plans based on new resource assignments.	
POIC develops integrated user ops execution plan.	IWG approves the POIC's execution plans.	
FIP finalized. Any changes made after this time are considered "replanning".		
SSSC resolves conflicts between user and systems requirements.	IWG resolves conflicts between user requirements.	
Conflict resolution process determines user resource envelope. Communications with payload and/or crew is planned for at this time as part of the envelope.	User plans DOC or UOF activities within the resource envelope.	
	At the user's site, user trains Station crew and ground personnel in the [goals,] ops and maintenance of his payload.	
	If payload has "complex" requirements, user delivers two high-fidelity copies of his payload to the Program for use in simulation and training.	
Program provides training for user.	User undergoes training.	

Program Actions	User Actions	NASA Sponsor Actions
	Payload is integrated into experiment racks or carriers at the S&T center, at the launch site by the Pre- and Post-Flight Ops Office, or at integration facilities provided by the Partners in the U.S. or abroad, per the PIP.	
Racks are integrated into logistic modules or pallets.	[User supervises integration to assure payload safety.]	
	User coordinates provision of any necessary spares or supplies to Logistics Ops Office.	
Logistics Ops Office provides launch site storage and preservation facilities available.		
Program hands modules and carriers to Office of Space Flight (OSF), which integrates the modules and carriers into launch vehicle.		
	User performs late payload access ops as necessary (e.g., animal feeding).	
[Launch]		
Crew installs new racks and equipment and performs initial checkout.	User issues commands required to complete checkout and verification and oversees crew checkout activities.	
Increment Ops begin.		

Program Actions	User Actions	NASA Sponsor Actions
Each day, SSSC updates the POIC on each Station system's status; POIC updates the IWG on status of user resource envelope.	IWG reps negotiate with POIC any changes to user plans to reflect any changes in the resource envelope, and coordinates changes to individual user plans. User reps negotiate new resource and time envelopes and forward modified consolidated plans to the POIC.	
POIC updates SSSC on user plans for integration with Station systems replanning data.	User performs any ops originating from his UOF and oversees any actions taken by the crew.	
POIC coordinates user commands and consolidates them for transmission via the SSSC. POIC also monitors all user ops to ensure conformance to ops plans and to detect any hazardous changes or trends. SSSC monitors system status and ensures that user ops don't adversely affect safety of crew or Station.	User monitors payload data and, if necessary, can request additional resources through the IWG to accommodate unforseen results. Any changes in ops (including any contingency ops) must be approved within the IWG, POIC and SSSC prior to implementation.	
[Flight increment nears completion.]	If payload will remain for next increment, user forwards any changes in resource requirements to UOIO for inclusion in next increment's plan.	
Changes in resource requirements for carry-over payloads are approved by POCB.		
[Flight increment ends.]	User shuts down payload for deintegration and specimen storage. User oversees payload takedown by crew.	

POIC integrates user
requirements; SSSC
integrates user ops with
systems changes during
increment handover.

[Payload returned to
Earth.]

Pre-/Post-Flight Ops   [User retrieves payload,
Office delivers racks   data, samples, etc. and
for deintegration.   performs analysis, etc.]
Logistics Ops Office
delivers payloads to
customers.

[Program issues Level 6   Users undergo
documentation (results of   debriefings with
debriefings and problem   Sponsor, PAM, UOIO, and
reports)]   Pre-/Post-Flight Ops
                              Office to help the
                              Program improve services
                              and interfaces, to help
                              the user plan his next
                              payload, and to help the
                              Sponsor determine the
                              utility of the Station in
                              fulfilling its goals.

                              [User publishes results   [Sponsor publishes
                              or findings and] archives   results of the projects
                              data and makes it   it supported.]
                              available to other users.